



**STRATEGY
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A REVOLUTION IN MILITARY ENGINEERING

BY

**LIEUTENANT COLONEL BRUCE J. PORTER
United States Army**

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Colonel John A. Bonin
Project Advisor

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U.S. Army War College
Carlisle Barracks, Pennsylvania 17013

ABSTRACT

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A new civilization is dawning as the world transitions from a Second Wave, industrial society to a Third Wave, information society. The armed forces of the United States plan to take advantage of new technologies and societal changes spawned by the Third Wave to drive a Revolution in Military Affairs (RMA). Many past RMAs have had a complementary Revolution in Military Engineering. The seeds for such a Revolution in Military Engineering were planted in America's Army when combat engineer units were reorganized under the Third Wave concept known as Engineer Force (E-Force). Four emerging engineer warfare areas will capitalize on E-Force so they will, collectively, energize the drive for a Revolution in Military Engineering: Prime Architect, Topographic Warfare, Virtual Battlespace Occupation, and Dominating Mobility. These areas combine new technologies, creative doctrine, and innovative organizations to offer "leap-ahead" capabilities for the combined arms force of the future. Achieving a Revolution in Military Engineering will cement the legitimacy of military engineering as one of the Army's core competencies.

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America's armed forces hope to capitalize on a "Revolution in Military Affairs" (RMA) as they conduct global operations and modernize in an environment of ambiguous threat and diminishing financial support. The Army hopes to take advantage of the RMA as it moves from its current structure, to Force XXI, to the Army After Next. A concurrent "Revolution in Military Engineering" promises to multiply the effects of the RMA. Engineering is a fundamental and enduring operating system at the strategic, operational, and tactical levels of war. Combat engineering, combat construction, and topographic engineering have historically been *core competencies* of the United States Army. The Revolution in Military Engineering will energize engineer functions at all levels so they will be a dynamo to transform the way America conducts war.

An Army and Society in Transition

An RMA may be defined as "a *fundamental* change, or discontinuity, in the way military strategy and operations have been planned and conducted."¹ A single technical innovation may drive an RMA, such as the introduction of the atomic bomb at the end of World War II.² Multiple new technologies combine with societal change, new operational concepts, and innovative organizational design to create some of history's most successful RMAs, such as that of Germany's *blitzkrieg*.³ Societal change, alone, may also drive a revolution, as did Napoleon's *levee en masse*.⁴ Contemporary thought places us in the midst of another RMA.⁵

The RMA now underway is auspicious in that a much larger shift is simultaneously taking place in the global community. Alvin and Heidi Toffler posit that a new civilization is dawning.⁶ American society is going through an epochal transformation from a "Second Wave," industrial civilization to a "Third Wave," information civilization.⁷ The way America organizes its society will be fundamentally the way it organizes to fight wars.⁸ The industrial age resulted in concepts of mass production and mass destruction.⁹ The information age will lead to de-massified, customized production and dispersed, precision destruction. It is against

the backdrop of a fundamentally changing society, a Third Wave civilization, that the RMA will take shape.¹⁰

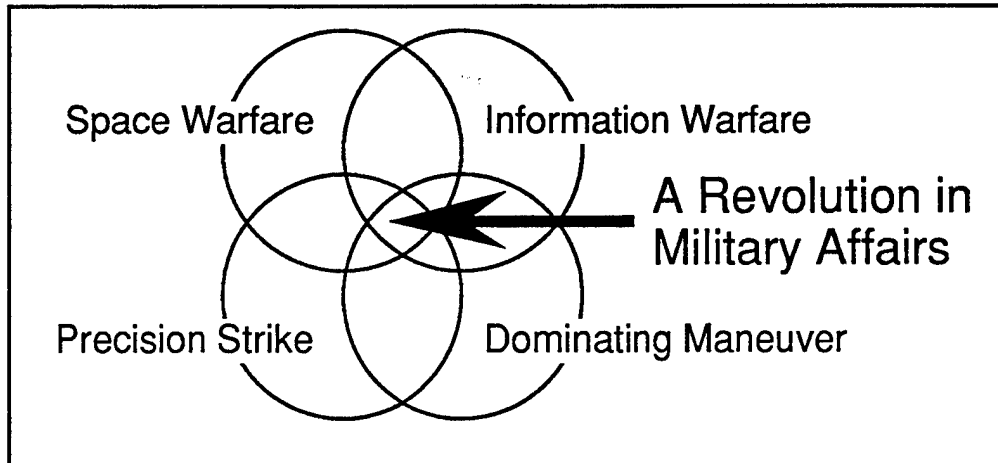


Figure 1 - Revolution in Military Affairs

Leaders hope to exploit radically advancing Third Wave technological, organizational, and operational concepts to empower four “Emerging Warfare Areas”—long-range Precision Strike, Information Warfare, Dominating Maneuver, and Space Warfare. America’s military leaders believe it is the *intersection* of these new warfighting concepts that will engender a Revolution in Military Affairs (Figure 1).¹¹

Genesis of a Revolution in Military Engineering

Many past RMAs had a counterpart Revolution in Military Engineering. The atomic bomb was in fact developed under the auspices of the Army Corps of Engineers’ Manhattan District (the genesis of the term, “Manhattan Project”).¹² The *blitzkrieg* relied on an enlarged divisional combat engineer organization, entirely new concepts of combat engineering, and development of mechanized breaching operations.¹³ Napoleon’s huge armies depended on new techniques of operational mobility (such as pontoon bridges) and fortifications assault.¹⁴

A new Revolution in Military Engineering has already been launched. The Chief of Staff of the Army triggered the revolution in 1991 when he directed implementation of a bold, command and control-oriented concept known as Engineer Force (E-Force).¹⁵ The E-Force concept began to turn combat engineering away from a Second Wave, labor-based, industrial activity, to a function of warfare based on agile command and control, information, and knowledge--Third Wave warfare.

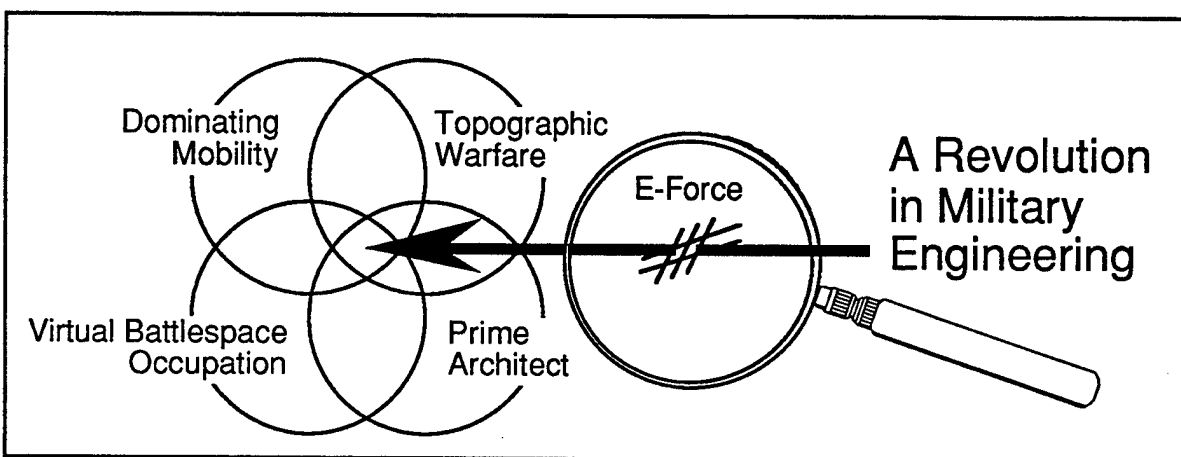


Figure 2 - Revolution in Military Engineering

The E-Force concept provides the warfighting lens through which four Emerging Engineer Warfare Areas have the potential to form a Revolution in Military Engineering. Each of them, taken separately, would not be considered revolutionary. The synergies developed by the components, collectively, will generate the revolution. The four Emerging Engineer Warfare Areas are Prime Architect, Topographic Warfare, Remote Terrain Occupation, and Dominating Mobility (Figure 2).

Prime Architect

Prime Architect embraces a new way of approaching engineering at the strategic and operational levels of war. Multiple agencies and commands now have missions to program,

construct, maintain, and manage America's power projection platforms. In a theater of war, yet another jumble of organizations and units is charged to develop infrastructure to receive, stage, integrate and sustain combat and support forces. Prime Architect sweeps aside these tangled webs of responsibilities. Prime Architect assigns to a single agent, the U.S. Army Corps of Engineers (USACE), all authority for the Army's installations and other selected key facilities in the United States. It likewise assigns to USACE the responsibility to command a theater-level engineer structure for all services in a theater of operations. The Corps of Engineers is the nation's premier engineering and construction organization; the concepts expressed herein leverage USACE's core competencies to transform the ways our armed forces execute strategy and conduct operations.

Army and National Power-Projection Platforms

The increasing proportion of Army forces stationed within the continental United States (CONUS) reinforces the requirement that Army installations function as fully-capable power projection platforms.¹⁶ Yet, the Army's installation infrastructure continues to deteriorate.¹⁷ Shrinking budgets exacerbate the problem and demand structural, not financial, solutions.

The Corps of Engineers enjoys unparalleled success in its Civil Works missions. Its various divisions, districts, and other components are often recognized for technical excellence, solid community relations, and innovation in organizational agility.¹⁸ Key to the success of the Civil Works program is its one-stop nature. Based on guidance from the local community, the Corps frames the project, then designs it, constructs it, operates it, and maintains it.

Military infrastructure programs do not enjoy the same perceived high level of success.¹⁹ The fundamental fault with military infrastructure lies in the fractured system now in place to plan, design, construct, and maintain facilities. The Department of the Army's Assistant Chief of Staff for Installation Management (ACSIM) programs requirements;²⁰ the Corps of Engineers designs and constructs the facilities;²¹ and each installation's Directorate of

Public Works (DPW) manages and maintains the completed facility for the rest of its life cycle.²² This system of fractured authority and responsibility is inefficient and ineffective.

The structure used by USACE to achieve excellence in its Civil Works mission will be leveraged to “fix” problems with military infrastructure. The Corps of Engineers will absorb those portions of the ACSIM organization that deal with infrastructure and absorb the organizations and responsibilities of installation DPWs. Each post’s DPW will be reorganized so that a large post’s DPW will be designated as an Engineer Region (for example, “US Army Engineer Region, Fort Hood”) and fall directly under an Engineer Division; small posts will have Area Offices under an Engineer District (for example, Fort Leavenworth Area Office, US Army Engineer District Kansas City) (Figure 3). Alternatively, a small post’s Area Office might fall under an Engineer Region, as a satellite office of the larger organization. Just as civilian customers set priorities and allocate funds for Civil Works projects, installation commanders will set priorities and manage the overall budget for public works on their posts.

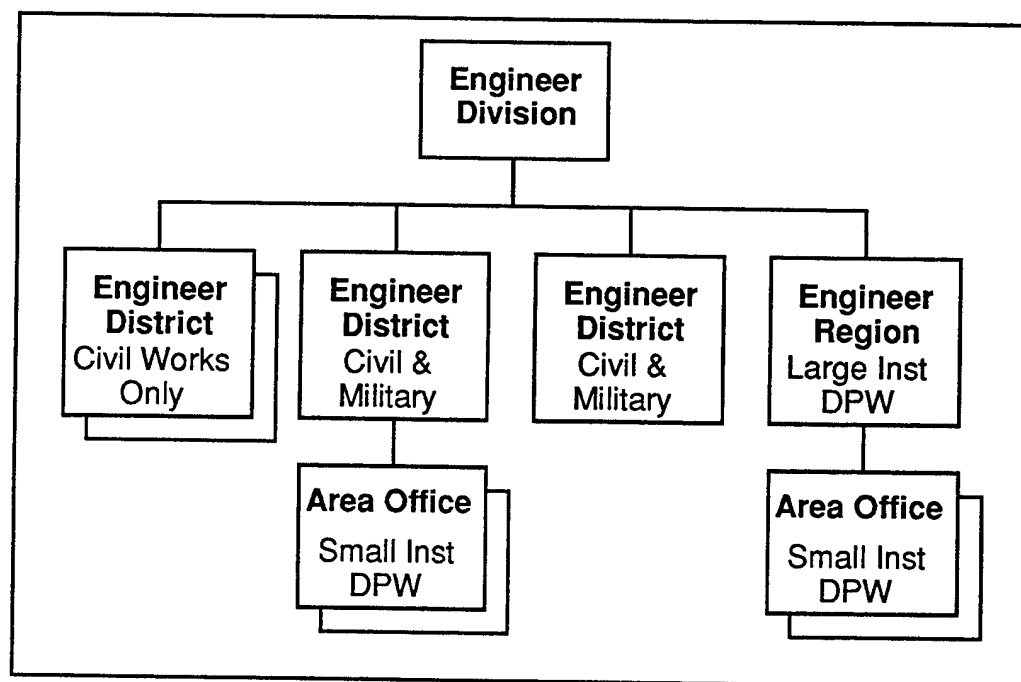


Figure 3 - Notional Engineer Division With DPW Responsibilities

Improved operations and efficiencies are tangible now and in the future. Redundant functions, such as the engineering and construction management structures for major construction (USACE) and minor construction (DPW), will be consolidated. Post DPWs will become a full partner in the larger community of engineers, instead of operating as separate entities. The post commander gets a single engineer he can reach out and touch for *all* aspects of his facilities, plus a higher engineer to whom he can appeal for special problems. USACE districts get full life-cycle responsibility and authority for a facility, instead of bearing criticism for failures of parts of a project over which they had no control. The designation of "regions" paves the way for consolidation of functions among base clusters as an option for future efficiencies. The inter-service nature of USACE missions opens the door for consolidation of functions at bases of different services. Most important of all, America's power-projection platforms will be better maintained and more efficiently managed.

There are other defense-related facilities that are not managed by the Army in peacetime, but which are critical to the national war effort. Sea ports, air ports, and space ports will be prime targets of future enemies who understand America's reliance on power projection and space warfare. The Corps of Engineers must be ready to execute repair missions if any of these are damaged. A special surge requirement may also be generated to upgrade launch facilities to replace destroyed space platforms.²³

Theater Engineer Command

There must be a major change, if not a revolution in and of itself, in the wartime theater engineer structure. The current structure is complex and choked with redundancies.²⁴ The main function of theater-level engineering is construction²⁵--*the core competency* of the Army Corps of Engineers. All theater engineer operations should be consolidated under a command of the Corps of Engineers.

Theater-level engineering has a complex and intertwining system of responsibilities and authorities. Joint doctrine holds each service responsible for its own theater construction, requires services to provide mutual support, and authorizes the combatant commander to transfer construction functions between services.²⁶ Joint doctrine further specifies a maze of overlapping theater-level engineer structures: a Joint Facilities Utilization Board, a Joint Civil-Military Engineering Board, a Theater Contingency Engineering Management Cell, a Regional Contingency Engineering Management Cell, a Joint Task Force Contingency Engineering Cell, and a Department of Defense (DoD) contract construction agent.²⁷ Mirroring the redundant command and control structures are the services' separate, clone-like construction units (Army engineer "combat heavy" battalions, Navy Seabee battalions, and Air Force Red Horse Squadrons) and contract construction management agencies (Army Corps of Engineers and Naval Facilities Engineering Command).

In a future environment of limited resources and emphasis on joint operations, there is no reason to retain these redundancies. There is no reason to maintain Seabee and Red Horse units when the same function can be accomplished by the most pervasive of the services' types of engineer units, Army combat heavy battalions. The Army should perform *all* the theater-level engineering functions for *all* the services.

The Army must streamline its own approach to establishment of theater-level engineer commands. There are two Army Reserve units designed for the task,²⁸ the 412th Engineer Command (ENCOM) and 416th ENCOM, but these are mobilized only for major conflicts; for lesser contingencies, a smaller engineer unit or an *ad hoc* engineer command is established. The Corps of Engineers is virtually always involved in the theater in a support role, and often has personnel in the theater even before the contingency arises.²⁹

The Army's logistics community would like to subsume theater engineer command missions and place the function under a new Theater Support Command.³⁰ But it is not clear how such an arrangement would impact on joint engineer operations when the Theater Support Command is not a joint organization,³¹ or how subordination to a combat service support

headquarters would affect theater engineer warfighting missions such as deep battle planning for Air Force-delivered scatterable mines.³²

The new theater engineer command will be seamless from the CONUS supporting base to the rear boundary of combat engineer units engaged in the direct fight. It will support all services deployed to the theater. It will be regionally engaged in peacetime and rapidly deployable in time of war. It will be responsive to commanders at all levels, to combat and support units alike. It will leverage the CONUS engineer base for expertise and resources.

To facilitate establishment of a theater engineer command in a contingency, the Corps of Engineers will affiliate an existing engineer division with each of the combatant commands (as USACE does now with the Pacific Engineer Division and U.S. Pacific Command). In peacetime the affiliated engineer division will provide direct support to the Unified Command's engineer staff and execute missions and programs in support of the combatant commander. In a contingency the affiliated engineer division will provide a crisis-response team to immediately establish a framework for the theater engineer command (as USACE already does now for the limited mission of real estate management);³³ personnel will often already be in-theater, executing engagement operations.³⁴ As the theater matures a troop unit (typically an engineer group, an engineer brigade, or an ENCOM, depending on the size of the contingency) may eventually be deployed as the theater engineer command, and incorporate the engineer division's command and control structure already in place.

The engineer command will command all construction-related units deployed to the theater. The command will also function as the theater wartime construction manager and the executing arm of the DoD contract construction agent. The engineer command will employ a mix of military personnel and civilians, troop units and contractors,³⁵ and US and host nation personnel,³⁶ as appropriate for the mission. The technical capabilities of the command will be anchored in the engineer division, with the entire Corps of Engineers employed in a direct support role. Other organizations in the United States, such as the National Imagery and Mapping Agency,³⁷ will be in general support.

The Corps of Engineers will command all stateside echelon-above-corps engineer units in peacetime. It already commands the 249th Engineer Battalion (Prime Power);³⁸ it will also command theater engineer brigades, engineer construction groups, engineer combat heavy battalions, and smaller organizations such as pipeline, port construction, firefighting, well drilling, and quarry units. This assignment will allow engineer construction units to leverage the construction technology used in the Civil Works and Military Programs functions of USACE. The Corps of Engineers will be charged to equip these units with the latest in technology, perhaps by leasing construction equipment instead of pursuing the traditional acquisition process.

Currently, nearly all engineer combat heavy battalions and other construction units are scattered as single units over many posts.³⁹ They are almost always attached to a non-warfighting combat service support headquarters (typically a support group or support command). The result has been little or no engineer professional development or oversight of these construction units. An engineer peacetime chain of command from the Chief of Engineers, through engineer group commanders to engineer battalion, company, and team commanders, will foster technical excellence and a focus on warfighting.

There are numerous other peacetime and wartime advantages to this reorganization. The combatant commander will be able to leverage a number of large and highly capable, professional engineer organizations, in peacetime as well as war. Engineer peacetime engagement and habitual affiliation will facilitate rapid transition to wartime operations.⁴⁰ Engineer organizations will be configured as modular, established teams, not knee-jerk *ad hoc* task forces. A single command that incorporates all aspects of theater engineering (joint force engineer, regional contingency engineering manager, DoD contract construction agent, and theater engineer command) will result in efficiencies in resources and qualitative improvement in effectiveness.

Topographic Warfare

Armies and their engineers have always been extraordinarily concerned with the earth's terrain and its effect on military operations. Topographic Warfare is a quantum leap beyond simple terrain analysis--it is the exploitation of a profoundly detailed knowledge of the terrain to conduct full-spectrum, near-real-time, global military operations. The intent is to wield our knowledge of terrain as a weapon, analogous to the way in which wide-area surveillance and target acquisition capabilities empower the Emerging Warfare Area of Precision Strike. Topographic Warfare leverages capabilities emerging from Information Warfare and Space Warfare. The Emerging Engineer Warfare Area of Topographic Warfare is a catalyst for all other emerging warfare areas, as well as virtually every other warfighting and support function.

Just as the Tofflers saw the rise of the "knowledge worker"⁴¹ in the Third Wave economy, Topographic Warfare will give rise to a topographic "knowledge warrior." The civilian worker and the military warrior are changing in tandem. Mindless warriors are to Third Wave war what unskilled manual laborers are to the Third Wave economy--an endangered species.⁴² The organic combat engineer unit, supported from the United States by strategic assets, will provide the means for the future battle force to execute all facets of Topographic Warfare.

The revolutionary potential of Topographic Warfare derives from technologies that provided a glimpse of their own potential in the Persian Gulf War. The American Army's concept of terrain information representation was still firmly grounded in the paper map.⁴³ Commanders used crude, manual techniques to integrate Global Positioning Satellite (GPS) data with paper maps to traverse what the Iraqis considered unnavigable desert.⁴⁴ Even that crude level of topographic sophistication dramatically impacted operations and tactics in the Gulf War.

Continued exponential improvements in computer processing speed and digital storage devices will innervate the means for executing topographic warfare.⁴⁵ Over the next several years, commercial corporations and military agencies will achieve global definition of the earth's surface to submeter accuracy.⁴⁶ Engineers will construct a wire-frame model of the world using this geophysical data.⁴⁷ At the strategic and operational levels, the National Imagery and Mapping Agency and engineer commands will build and maintain digital databases⁴⁸ of various features of the earth (geography, climate, minerals, vegetation, political, cultural and social) which can be projected onto the global wire-frame model. All units will carry a basic load of "base" imagery covering the theater of operations.

Tactically, engineers will obtain mission-specific imagery from satellites, aircraft, unmanned aerial vehicles, and other platforms. Dismounted troops will use cameras whose imagery can be downloaded to the digital database.⁴⁹ Combat engineer and other reconnaissance elements may add data gleaned from subsurface areas such as river bottoms, tunnels, and caverns.⁵⁰ Engineers will drape acquired imagery in layers over the foundation wire-frame model, then manipulate the data into unit-usable three-dimensional models.⁵¹

Commanders will download mission-significant data over the tactical internet, then use the data for mission planning, rehearsal, and refinement. These phases may be conducted in parallel, almost simultaneously, as commanders execute "what-if" drills.⁵² Planners will use a synthetic theater⁵³ to manipulate topographic data to interactively develop their plans. The synthetic theater will synergistically incorporate data from friendly forces and intelligence on the enemy to construct a fully-interactive, three-dimensional environment. As the plan begins to unfold, dispersed leaders will enter the synthetic theater to rehearse the operation and, simultaneously and interactively, build their own plans.

Units throughout the battlespace will eventually enter the synthetic theater to conduct their own planning and rehearsals. Commanders at all levels will iteratively refine their plans, then broadcast mission and terrain data to subordinate units for further planning, rehearsal and ultimately execution. At the lowest level, vehicle commanders and dismounted troops will use

the synthetic theater to rehearse and refine their individual maneuver over the terrain. Engineers will use electronic agents to analyze and recommend various routes through unknown terrain. Engineers will also use the synthetic theater to predict effects as terrain is modified during the course of the operation.

During mission execution, engineers will use imagery generated from strategic, operational, and tactical sources to record information on the earth's surface as it is transformed by cross-country maneuver, weather, mining, indirect fires (to include unexploded ordnance), rubble, and other battlefield clutter.⁵⁴ Information will be broadcast in near-real-time throughout the force to provide a seamless view of the battlefield to all decision-makers.⁵⁵

Commanders will also use the synthetic theater for peacetime training. Engineers will provide topographic data sets from any region of the world to train the forces of America's power projection, "go anywhere" Army. The same equipment used to project the synthetic theater for wartime planning and rehearsals will be perfectly suited to conduct economical, high-quality training in peacetime.

Virtual Battlespace Occupation

Virtual Battlespace Occupation is a revolutionary means for a commander to dominate an area and associated low-level airspace without occupying that area with troops. The domination provided by Virtual Battlespace Occupation is more robust than domination provided solely by long-range precision strike. Virtual Battlespace Occupation provides a powerful option to a combined arms commander as he contemplates an increasingly empty, non-linear battlefield.

Combat forces will inevitably become smaller and more dispersed, yet focused more tightly on high-priority strategic and operational enemy centers of gravity. Commanders will take advantage of "dominant battlefield awareness" to monitor unoccupied, lesser-priority areas of the battlespace.⁵⁶ But there will be circumstances when a commander wishes to deny terrain

to an enemy, but can't occupy it with forces and can't dedicate long-range precision strike weapons (or the required sensors) to dominate it from afar.

Engineers have historically fought as infantry, often as an economy of force measure: the engineer unit typically concentrated on a secondary piece of terrain, while more potent armor and infantry units focused on defeating the enemy force. The concept of Virtual Battlespace Occupation is the Third Wave extension of economy of force. It allows the maneuver force to concentrate elsewhere on enemy *forces* while the engineer concentrates on assigned *terrain*. The concept is enabled by a suite of new technologies in sensors, robotics, autonomous systems, wide area munitions, command and control systems, anti-helicopter mines, intelligent minefields, and non-lethal antipersonnel weapons systems. All of these new capabilities are lightweight, easy to deploy, and inexpensive in comparison with combat units and long-range precision strike weapons.

To "occupy" battlespace requires that an armed unit be physically on the ground, able to apply fire and maneuver to deny the terrain to any challenging enemy. Instead of a "real" armed unit, Virtual Battlespace Occupation substitutes unmanned sensors, remote command and control, and in-place precision strike weapons bunched into "arsenal nodes." Arsenal nodes may be of various sizes and composition, based on complexity of the terrain and nature of the enemy. Precision strike weapons in the arsenal nodes will be advanced versions of today's wide area munitions, anti-helicopter mines, and non-lethal antipersonnel systems. Arsenal nodes will have a robotic ability to move around the battlespace under the distant control of humans. While this suite of capabilities can't actually "maneuver," it can leverage "positional advantage," which lies at the heart of the concept of maneuver.⁵⁷

For virtual occupation, forces will emplace a web of sensors and arsenal nodes across the battlespace (Figure 4). Sensors will monitor activity within and around the occupied

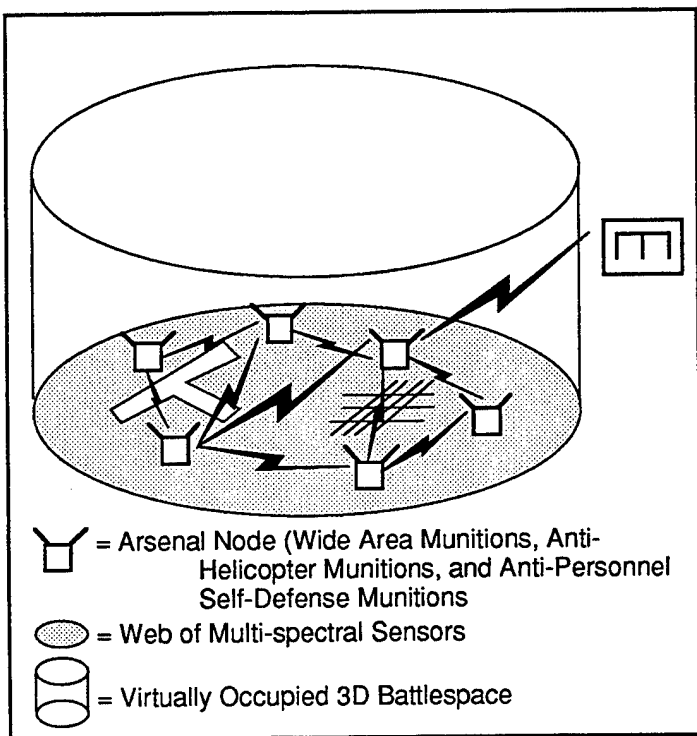


Figure 4 - Virtual Battlespace Occupation

battlespace, and communicate with the web's arsenal nodes and remote human controllers. The approach of personnel, vehicles, or low-flying aircraft will key sensors to analyze the data, apply engagement criteria, then, if indicated, trigger the arsenal nodes to apply the correct munition to attack the enemy. Sensors may trigger action according to a programmed recognition algorithm or only after a human decision is made, according to the

commander's desires. Multi-spectral sensors will differentiate between types of aircraft and vehicles. Sensors and arsenal nodes will communicate with one another to plan optimal attack patterns and engage in coordinated ambushes.

In many ways, Virtual Battlespace Occupation establishes a very "thick" barrier trace that is similar to today's linear obstacles. Like today's obstacles, the virtually occupied battlespace may serve to turn, fix, block, or disrupt enemy formations. The difference lies mostly in the more robust geometry of the feature, its ability to "overwatch itself," and an ability to turn the sensor-weapon web "on" and "off."

There will be a wide variety of applications for Virtual Battlespace Occupation. The commander may wish to virtually occupy the terrain used by the enemy to maneuver his mobile missile launchers, or outside caves used by enemy missiles for protection. Large facilities such

as airfields, rail yards, and port facilities will also be candidates for virtual occupation. Even towns occupied by civilians may be virtually occupied if we size and position arsenal nodes to account for the complexity of urban terrain, and when we reach the level of sophistication to program arsenal nodes to differentiate between civilian and military targets.

Virtually occupied battlespace doesn't achieve the degree of "control" that combat forces exert when they truly occupy terrain. However, virtually occupied battlespace can provide a potent option for a commander engaged in warfare with limited personnel, constrained lift capacity, and finite numbers of long-range precision strike weapons.

Dominating Mobility

To realize the Emerging Warfare Area of Dominant Maneuver, the Army is searching for a Holy Grail--an order of magnitude increase in the mobility of combat units as they traverse the battlespace.⁵⁸ Solutions contemplated to date have focused mostly on *operational* mobility. A favored approach is "air mechanization," a technique in which a unit's combat and support vehicles are lifted to a point on the battlefield by an oversized Osprey-type tilt-rotor aircraft.⁵⁹ The concept is an extension of the Air Assault Division's ability to transport light forces. Unfortunately, the analogy with the Air Assault Division goes further, to the problem encountered after the combat force leaves the air carrier--*tactical* mobility. While much can be done by maneuver units to improve their own tactical mobility, there will be no Holy Grail in the Pentagon's trophy cabinet without a revolution in terrain-oriented engineer mobility capabilities--"Dominating Mobility."

Tactical mobility is a function of several variables:

- the vehicle's raw road speed, hopefully up to ninety miles per hour⁶⁰
- the vehicle's dimensions and other physical characteristics
- natural obstacles, such as rivers, defiles, marshes

- man-made obstacles, such as mines, wide area munitions, unexploded ordnance, rubble, tank ditches, abatis, and craters

Combat and support vehicles should be built so as to maximize their potential for tactical mobility. However, construction of these vehicles is a tradeoff between firepower, protection, mobility (operational and tactical), and cost. Unfortunately, the assumption used in the Army After Next process has been that combat vehicles will be “perfectly” tactically mobile; that is, they will not require engineer assistance to cross or breach natural and man-made obstacles.⁶¹ Such an assumption is patently absurd. Pursuing this assumption for too long will lead to retarded development of engineering capabilities to support the future battle force.

Combat formations will require *combat engineers* to execute mobility operations if Dominant Maneuver is to be achieved at the tactical level. To achieve dominating mobility, combat engineers will perform many of the same missions they do today, but more quickly, more efficiently, and more dispersed in the battlespace. The engineer component of the future battle force must be modular and scaleable. It must operate in a dispersed mode to effect mobility for dispersed maneuver forces, and must mass for a major operations such as a breach of a prepared defense. The engineer force will engage in direct combat as it executes mobility missions, and must be survivable and lethal to accomplish those missions.

Designing for Failure ... or Success?

The Army is creating new organizational designs with little analysis or discourse on requirements for tactical mobility.⁶² The Army’s Training and Doctrine Command (TRADOC) did zero analysis before it cut an engineer battalion from the Division XXI design,⁶³ but will spend millions of dollars testing the design using a simulation that cannot measure the effectiveness of habitual maneuver-engineer relationships or repetitive shared training events. The TRADOC concept for the organization to follow Division XXI, the Army After Next, transfers 100% of combat engineer functions to maneuver units.⁶⁴ The series of RMA workshops conducted by contractors for the Army are notable for almost no discussion of

tactical mobility--entire volumes have been published with little or no mention of obstacles, breaching, engineers, or crossing complex terrain.⁶⁵

The engineer force must be custom-tailored to meet the mobility requirements of the future battle force. Without knowing its exact structure, there are some general design criteria that must be applied to achieve success. These criteria involve the command structure, tough soldiers, modern equipment, and broadened capabilities.

Command Structure

The E-Force concept which now organizes combat engineers at the tactical level is the right concept for the future force. Though echelons of command may be reformulated, the general principle still applies: if a combined arms command has "x" maneuver units, it should have one engineer unit with "x" engineer sub-units; additional engineer units should be available at a higher echelon to reinforce organic engineers, or augment them with special capabilities. Such an organization is modular, can be scaled to the appropriate level to support dispersed maneuver units, and can be massed under a higher engineer headquarters for an engineer-intense effort. The planned Division XXI structure fails all these design criteria.

The Combat Engineer Soldier

The combat engineer, the sapper, must be the toughest of combat arms soldiers. He is a special breed. He assaults fortifications with satchel charges, hand grenades, and bayonet. He works intimately with demolitions and mines encased in webs of cunning boobytraps. He disposes of unexploded ordnance with little or no training. He leads the way into the breach, in front of tanks and infantry. He is the defending enemy's number one priority to destroy.⁶⁶

Many of the combat engineer's tasks seem to be those of a Second Wave, or even First Wave, military organization. But mobility is, by its very definition, a reaction taken against an action of the enemy or the nature of the terrain. There are some aspects of enemy operations that can be countered by American Third Wave tactics--Topographic Warfare may reveal ways

to bypass enemy obstacles, and robotics may perform certain breaching operations. But there will be times when First Wave enemy tactics, such as use of a defended riverline, will require the same basic mobility tactics as those employed by Alexander at Tyre.⁶⁷

Topographic Warfare and other Third Wave American techniques must be incorporated into the concept of Dominating Mobility. However, just as there will be times when there must be an infantryman standing on the objective, there will be times when there must be an engineer astride the breach. Even deep into the Third Wave, heroism, courage, and toughness will be the hallmarks of those soldiers who engage the enemy "up close and personal."⁶⁸

The Combat Engineer's Equipment

Yet the combat engineer is arguably the most poorly equipped and poorly protected combat arms soldier on the battlefield. The Revolutions in Military Affairs and Military Engineering must be leveraged to provide these courageous soldiers the equipment they deserve and require. Our Army has never fielded a custom-built engineer squad vehicle. In the best of times, engineers have used the same vehicle as infantrymen; in the worst of times, they have used older, less protected, less mobile, more poorly armed vehicles. After action reports from World War II to the Persian Gulf War⁶⁹ have consistently called for engineers to use the same combat vehicle as their supported infantry.

Other specialized engineer equipment such as earthmovers, breachers, and bridgers should be at least of the same generation as maneuver vehicles. They should have the same mobility, communications, and information processing equipment as those of supported units. It will be almost two decades after the fielding of the Abrams tank before the M48A5-based armored vehicle launched bridge will be replaced by a modern chassis--a situation proven disastrous in the Persian Gulf War.⁷⁰ It is imperative the Army pursue acquisition of the "Grizzly" breacher and "Wolverine" heavy assault bridge to provide a credible mounted combat engineer capability for the Abrams/Bradley force of the first part of the 21st Century.

Broadening the Capabilities of the Combat Engineer Force

Combat engineers already provide a bonus to the Army in their secondary mission as Infantry. There are two additional ways for combat engineers to add significant capabilities for Dominating Mobility to the tactical-level battle force. The first is to incorporate an organic explosive ordnance disposal (EOD) capability; the second is to cross-train combat engineers in general engineering skills.

Broadened Capabilities: Combat Engineers and Explosive Ordnance Disposal

The division of labor between Ordnance Corps EOD detachments and engineers is inefficient and deadly. EOD units are neither equipped nor trained to operate in forward combat areas⁷¹--the roots of their organization lie in the Second Wave need to disarm big, iron bombs in rear areas. Invariably, engineer units are called upon to mark and destroy sophisticated munitions encountered by attacking combat formations.⁷² The use of cluster-type munitions, delivered by aircraft, artillery, and rockets, has led to increasingly dense concentrations of unexploded ordnance.⁷³ These concentrations of unexploded munitions constitute virtual minefields--unmarked, poorly defined minefields. Unexploded precision munitions cause special problems: they are often hypersensitive to temperature or radiation changes caused even by a soldier's shadow. Dealing with this array of complexity and lethality demands highly-trained EOD personnel, yet combat engineers most often deal with the problem.⁷⁴

The solution is to fold the EOD mission into engineering and change authorization documents to require selected soldiers at engineer battalion level to achieve EOD qualification. The result will be increased speed and agility for combined arms forces as their organic engineers safely deal with inevitably-encountered unexploded ordnance. The Engineer Command at theater level will have an EOD capability for rear areas. Support for civil authorities can be provided by engineer EOD personnel under the command of USACE

Engineer Districts --organizations that already cover every municipality in every state and territory of the country.

Broadened Capabilities: Combat Engineers and Construction Engineering

Military engineering includes two broad categories: combat engineering and general engineering. Attempts to sharpen the focus of division engineer units have driven virtually all general engineering capabilities to echelons above division. Yet many general engineering skills are often needed in forward areas, especially during the strategic and operational maneuver phases of an operation. At a very small cost, the Army can multiply engineer effectiveness by cross-training combat engineers in general engineering skills.

Combat engineers can be cross-trained in general engineering skills in their units during non-peak training cycles. Every Army unit goes through a “red cycle” of post support operations. Soldiers stand down from tactical training to help run gymnasiums, guardhouses, landfills, washracks, and supply shops, and serve as drivers, lifeguards, and groundskeepers. Combat engineers can serve their “red cycle” time at the installation DPW. There they will learn to be carpenters, electricians, plumbers, and masons, and at the same time help DPW execute small repair and maintenance programs.

Minor changes to authorization documents will multiply the effectiveness of this effort. The Army should add an Engineer Utilities warrant officer to the headquarters of each engineer battalion to conduct cross-training, and plan general engineering operations when the unit is deployed for operations (especially operations other than war). Limited equipment for these functions--mostly inexpensive handtools--should also be added to unit tool authorizations.

The Army will not attain “Dominant Maneuver” unless it achieves “Dominating Mobility” through its combat engineer units. The engineer force must be crafted as an integral piece of the future battle force--with the concept of E-Force as the principle for organizational design. Even minor structural changes, such as EOD re-alignment and cross-training in general engineering skills, can provide major qualitative improvements in the future force.

Conclusion

This description of a Revolution in Military Engineering includes the first step, E-Force, taken to *fundamentally* alter the way the American Army conducts military engineer operations. It further projects the four emerging engineer warfare areas that will cement the Revolution in Military Engineering for both the Army and Department of Defense. Projections and recommendations are based on various core competencies as already demonstrated by various parts of the Army and Corps of Engineers, and potential for radical improvement through the fusion of new technologies with innovation in organizational design and doctrinal agility.

Yet the thoughts herein are neither prescriptive nor definitive. They are meant to stimulate thinking about warfare and the role of military engineering as the Army reorganizes under Force XXI and later the Army After Next.

But beyond thinking about it, engineer and other leaders must change the way they look at changing for the future. As an organization, the Army must "break out of the box" of focusing solely on infantry, armor, artillery, and aviation. Divisions from the "Army of Excellence" era were designed exactly that way. The result in the Persian Gulf War was engineer companies mounted in dump trucks maneuvering alongside M1A1 tanks and M2A2 Bradleys, through direct and indirect fires, to execute tasks critical to overall mission accomplishment. While heroic, the spectacle was institutionally shameful. Unfortunately, the same planning paradigm has been institutionalized by TRADOC analysts as they design Division XXI and the Army After Next.

Military engineering has always been a core competency of the Army. There is vast potential for leveraging this core competency. The Army and Department of Defense should take maximum advantage of this opportunity as America reshapes its military establishment.

ENDNOTES

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